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Specification

Former for a Strip-Producing or Strip-Processing Machine

The invention relates to a former of a web-producing or web-processing machine in accordance with the preamble of claim 1 or 2.

A former is known from DE 44 35 528 A1, which has air outlet openings on its side which is acting together with the web. By arranging openings in a base plate and in a counter-plate, which can be displaced in respect to the base plate, the effective air outlet openings can be varied from a maximum size (full coverage) to zero (no coverage).

USP 5,423,468 A1 shows a guide element having an inner body with bores and an outer body of a porous air-permeable material. The bores in the inner body are only provided in the expected looped area.

A sheet-conducting installation is known from DE 198 54 053 A1, wherein blown air flows through bores, slits, porous material or nozzles in a guide area of a guide element and in this way conducts the sheet in a contactless manner.

The object of the invention is based on producing formers for a web-producing or web-processing machine.

In accordance with the invention, this object is attained by means of the characteristics of claims 1 or 2.

The advantages to be gained by means of the invention consist in particular in that a former is created which operates at a very low friction. By means of an air cushion created by micro-openings, a large degree of homogeneity is produced over the extent of the air cushion simultaneously along with small losses.

By means of air outlet openings with diameters in the millimeter range, forces can be applied point-by-point to the material (impulse of the jet), by means of which the latter can be kept away from the respective component, while by means of the distribution of micro-openings with a high hole density a broad support and, as a matter of priority, the effect of a formed air cushion is applied. The cross section of bores used up to now lay for example in the range between 1 and 3 mm, while the cross section of the micro-openings is smaller by at least the power of ten. Substantially different effects arise from this. For example, the distance between the surface with the openings and the web of material, for example a web or a strand, can be reduced, the flow volume of flow means can drop considerably and by means of this, flow losses which possibly occur outside of the areas which act together with the web can be clearly reduced.

In contrast to components with openings, or bores, with opening cross sections in the millimeter range and a hole distance of several millimeters, a greatly more homogeneous surface is created with the formation of micro-openings on the surface. Here, micro-openings are understood to be openings in the surface of the component which have a diameter of less than or equal to 500 μm , advantageously less than or equal to 300 μm , in particular less than or equal to 150 μm . A "hole density" of the surface provided with micro-openings is at least one micro-opening per 5 mm^2 ($=0.20/\text{mm}^2$), advantageously at least one micro-opening per 3.6 mm^2 ($=0.28/\text{mm}^2$).

The micro-openings can be advantageously designed as open pores at the surface of a porous, in particular micro-

porous, air-permeable material, or as openings of penetrating bores of small diameter, which extend through the wall of a supply chamber toward the exterior.

In order to achieve a uniform distribution of air exiting from the surface in the case of employing micro-porous material, without requiring at the same time large layer thicknesses of the material with high flow resistance, it is useful for the former to have a rigid air-permeable support in the appropriate area, to which the micro-porous material has been applied as a layer. Such a support can be charged with compressed air, which flows out of the support through the micro-porous layer and in this way forms an air cushion on the surface of the component.

The support itself can be porous and have a better air permeability than the micro-porous material, but it can also be formed of a flat material or shaped material, which encloses a hollow space and is provided with air outlet openings. Combinations of these alternatives can also be considered.

For achieving a uniform air distribution it is moreover desirable that the thickness of the layer correspond to at least the distance between adjoining openings.

In case of using micro-bores, an embodiment is advantageous, wherein the side of the former which faces the web and has the micro-openings is embodied as an insert or as several inserts in a support. In a further development, the insert can be releasably or, if desired, exchangeably connected with the support. In this way cleaning and/or an exchange of inserts with different micro-perforations for

adaptation to different materials, web tensions, number of layers in the strand and/or partial web widths is possible.

Exemplary embodiments of the invention are represented in the drawings and will be described in greater detail in what follows.

Shown are in:

Fig. 1, a schematic section through a first embodiment of the former with porous material,

Fig. 2, a section perpendicularly in respect to Fig. 1 through a leg area of the former,

Fig. 3, a schematic section through a second embodiment with porous material,

Fig. 4, a schematic section through a third embodiment with porous material,

Fig. 5, a schematic view from above on a support body of a former in accordance with Figs. 3 or 4,

Fig. 6, a schematic section through a first embodiment of the former with micro-bores,

Fig. 7, a section perpendicularly in respect to Fig. 6 through a leg area of the former,

Fig. 8, a a schematic section through a second embodiment with micro-bores,

Fig. 9, a schematic section through a third embodiment with micro-bores,

Fig. 10, a schematic view from above on a former with a separate nose section,

Fig. 11, a schematic front view on a folding device having micro-openings.

A schematic section through a former 01, through which a web 06, for example a web 06 of material or web 06 of material to be imprinted, runs is shown in Fig. 1. The former 01 has two leg areas 03, which come together at an acute angle, as well as a nose section 04, as well as a traction roller pair 02 at the vertex of the angle formed by the outsides of the leg areas 03. The web 06 is fed to the former 01 from above parallel with the drawing plane, and in the course of the passage through the former 01 the lateral edges of the web 06 of material are flipped out of the drawing plane, so that a web 06 is created which has been folded once and which passes through the traction roller pair 02 in an orientation transversely in relation to the drawing plane. This also applies in the same way if, in place of a web 06, a partial web or a strand of webs, or partial webs, lying on top of each other, is conducted over the former 01.

On an outside of at least one section of its leg area 03, or its leg areas 03, which act together with the web 06, the former 01 has opening 10 embodied as micro-openings 10. At least in this area it has a hollow inner space 07, or hollow space 07, which can be charged with compressed air by a feed line, not represented.

A fluid, for example a liquid, a gas or a mixture, in particular air, which is under higher pressure than the surroundings, flows through the micro-openings 10 from the hollow space 07, for example the chamber 07, in particular the pressure chamber 07, during the operation. An appropriate feed line for compressed air into the hollow space 07 is not represented in the drawings.

In a first embodiment, the micro-openings 10 are embodied as open pores on the surface of a porous, in particular micro-porous, air-permeable material 09, for example an open-pored sinter material 09, in particular a sinter metal. The pores of the air-permeable porous material 09 have a mean diameter (mean size) of less than 150 μm , for example 5 to 60 μm , in particular 10 to 30 μm . The material 09 is designed with an irregular amorphous structure.

At least in the area acting together with the web 06, the hollow space 07 can essentially only be made of a body of porous solid material (i.e. without any further load-bearing layers of appropriate thickness) closing the hollow space 07 off on this side. This substantially self-supporting body is then designed with a wall thickness of more than or equal to 2 mm, in particular more than or equal to 3 mm. In this way two tube-shaped bodies made of the porous material 09 could for example constitute the leg areas 03 of the former 01 and, if desired, a suitably shaped hollow body made of the material 09 could form the nose section 04, called nose 04 for short. Furthermore, the entire former 01, including a former plate, can be embodied with the micro-porous layer 09.

For achieving a uniform distribution of the air exiting at the surface of the micro-porous material 09, without requiring at the same time large layer thicknesses of the material 09 with a correspondingly high flow resistance, it is provided in a first embodiment (Fig. 1) that in the leg area 03 the former 01 has a solid support 08, in particular a support body 08, which is air-permeable at least in part and on which the micro-porous material 09 has been applied as a layer 09. Such a support body 08 can be charged with

compressed air, which flows out of the support body 08 through the micro-porous layer 09 and in this way forms an air cushion at the surface of the leg or nose sections 03, 04. In a particularly advantageous embodiment the porous material 09 is therefore not embodied as a supporting solid body (with or without a frame structure), but as a layer 09 on a support body 08, which has passages 15 or through-openings and is in particular made of a metallic support material. A structure is understood to be the "non-supporting" layer 09 together with the support body 08 - in contrast to, for example, the "self-supporting" layers known from the prior art -, wherein the layer 09 is supported over its entire layer length and entire layer width on a multitude of support points of the support body 08. For example, the support body 08 has over its width and length which is active together with the layer 09 a plurality of non-connected passages 15, for example bores 15. This embodiment is clearly different from an embodiment in which a porous material extending over the entire active width is designed to be self-supporting over this distance, and is only supported in the end area on a frame or support, and therefore must have an appropriate thickness.

The leg areas 03 of the former 01, embodied as web guide plates 03 in Fig. 1, are each constituted by a support 08, for example a housing made of sheet metal, whose side facing the web 06 of material has a multitude of openings and supports the micro-porous layer 09. An air flow, which flows from the inner chamber 07 through the micro-porous layer 09, forms an air cushion on the surface of the latter, which prevents direct contact between the web guide plates 03 and

the web 06 to be guided by them. Therefore the web 06 passes through the former 01 smoothly and uniformly without the danger of becoming stuck or of damage to the web.

An embodiment in particular is advantageous wherein, in the area of its converging cheeks, the former 01 is embodied with the passages 15 and the layer 09 at least in the bending area, i.e. in the area of the "edge" which changes the direction of the web. These passages 15 and the layer 09 can be arranged in the area of the cheeks, as well as in the edge area of the surface, i.e. can pass around the folding edge. Advantageously this folding edge is not made with a sharp edge, but has a curvature with a radius R. A section through a side of the former 01 in the leg area 03 of an advantageous embodiment is represented in Fig. 2. The "edge" which is effective for folding is formed by a support 08 embodied as a tube 08 (or spar 08), which has openings of the bores 15 at least in a looped-around or contact area with the web 06 and is coated with the micro-porous layer 09. In principle, two such converging tubes 08 having appropriate bracing for forming the former 01, are sufficient as a former 01. In the exemplary embodiment, the former 01 has a cover 11, for example a former plate 11, plate 11 for short, between the two spars 08 which, as shown, terminates flush with the effective surface of the spar 08. However, for forming a free space between the plate 11 and the tensed web 06, it could be arranged offset "toward the bottom" away from the web 06. This plate 11 can also be embodied as a whole or in parts with openings 10, 15 and, if desired, with the layer 09, against which compressed air is blown from "below" out of a hollow space (only indicated by dashed lines).

In an embodiment, not represented, the former 01 can also be designed to be divided. This means that each of the two spars 08, together with "half" a former plate 11, form a symmetrical half of the upper former area. A common nose section 04 is assigned to the two former halves. What has been said in connection with the other embodiments regarding the spars 08 and the nose section 04 then also applies.

Fig. 3 shows an embodiment wherein the areas on which compressed air is blown and which is provided with the layer 09 and bores 15 come together to form a common hollow space 07 in the nose section 04. There, too, bores 15, as well as the layer 09, are arranged, at least in the area of the surfaces acting together with the web 06.

In a further development of the representation in Fig. 3 it is possible - for example with a uniform coating - to embody the hollow space 07' in the nose section 04 separately from the hollow space 07 of the leg areas 03 and to provide its own supply with compressed air. In this case the nose section 04 and the leg area 03 can be charged with different pressures (for example higher in the nose section 04), for example.

The choice of material, the dimensions and charging with pressure have been selected in such a way that 1 to 20 standard cubic meters per m^2 exit from the air outlet surface of the sinter material 09 per hour, in particular 2 to 15 standard cubic meters per m^2 . An air output of 3 to 7 standard cubic meters per m^2 is particularly advantageous.

The sinter surface is advantageously charged with excess pressure of at least 1 bar, in particular more than 4 bar, from the hollow space 07. A charge of the sinter

surface with excess pressure of 5 to 7 bar is particularly advantageous.

An embodiment of the former 01 is represented in Fig. 4, wherein micro-porous materials 09, 09' of different properties and/or layer thickness are used for the layer 09 in different areas of the former 01. The layer 09' in the nose section 04 is embodied in such a way that, for example, the exiting air flow per unit of area is greater than in the cheek, or leg area 03 of the former 01. Therefore the nose section 04 has a layer 09' of the material, whose mean pore size is greater, the proportion of open external surface per unit of area is greater and/or the layer thickness is less than with the material of the layer 09 in the leg area 03. Therefore the air-permeable material 09 of the leg area 03 has, for example, pores of a mean size of 10 to 30 μm , and the nose section 04, for example, of 25 to 60 μm . As represented, the area of the different layers 09, 09' can be provided with compressed air via a common chamber 07 (hollow space 07). But separate chambers 07 can also be provided for this, which can then possibly be charged with compressed air of different pressure. As a result (variation of the pore size and/or pressure), the air output in the leg area 03 lies for example between 2 to 15 standard cubic meters per m^2 , and that in the nose section 04 between 7 and 20 standard cubic meters per m^2 , with the condition that the latter be greater than the former.

Fig. 5 schematically represents a view from above on the former 01 with converging spars 08 and the in the nose section 04. However, the representation shows the former 01 without the layer 09 (or the layers 09, 09' of different

layer material), so that the sketched-in openings of the passages 15 are visible.

In the exemplary embodiments represented, the support material 08 substantially absorbs the weight, shear, torsion, bending and/or shearing forces of the component, because of which an appropriate wall thickness (for example greater than 3 mm, in particular greater than 5 mm) of the support body 08 and/or an appropriately reinforced construction have been selected. The porous material 09 outside of the passage 05 has a layer thickness which, for example, is less than 1 mm. A layer thickness between 0.05 mm and 0.3 mm is particularly advantageous.

A proportion of the open face in the area of the effective outer surface of the porous material, here called degree of opening, lies between 3% and 30%, preferably between 10% and 25%. For achieving an even distribution of air it is furthermore desirable for the thickness of the layer to correspond at least to the distance between adjoining openings of the bores of the support body 08.

The wall thickness of the support body 08, at least in the area supporting the layer 09, 09', is greater than 3 mm, in particular greater than 5 mm.

The support body 08 can itself also be made of a porous material, but with a better air permeability - for example a greater pore size - than that of the micro-porous material of the layer 09. In this case the openings of the support 08 are constituted by open pores in the area of the surface, and the passages 15 by channels which are incidentally formed in the interior because of the porosity. However, the support body 08 can also be constituted by any arbitrary flat

material enclosing the hollow space 07 and provided with passages 15, or by shaped material. Combinations of these alternative can also be considered.

The interior cross section of a feed line, not represented, for supplying the compressed air to the former 01 is less than 100 mm^2 , it preferably lies between 10 and 60 mm^2 .

In a second embodiment (Figs. 6 to 9), the micro-openings 03 are designed as openings of penetrating bores 12, in particular micro-bores 12, which extend outward through a wall 13, for example a chamber wall 13, bordering the hollow chamber 07, for example designed as a pressure chamber 07. In the leg area 03, the chamber wall 13 can be advantageously designed as a tube 13 or spar 13. The bores 12 have, for example, a diameter (at least in the area of the openings 10) of less than or equal to $500 \mu\text{m}$, advantageously less than or equal to $300 \mu\text{m}$, in particular between 60 and $150 \mu\text{m}$. The degree of opening lies, for example, between 3% to 25%, in particular 5% to 15%. A hole density is at least $1 / 5 \text{ mm}^2$, in particular at least $1 / \text{mm}^2$ up to $4 / \text{mm}^2$. Therefore the wall 13 has a micro-perforation, at least in a leg area 03. In an advantageous manner, the micro-perforation - the same as the passages 15 and layer 09 in the first exemplary embodiment - extends at least through the leg are 03 and a nose section 04.

A wall thickness of the chamber wall 13 containing the bores 12 which, inter alia, affects the flow resistance, lies between 0.2 to 0.3 mm, advantageously between 0.2 to 1.5 mm, in particular between 0.3 to 0.8 mm. A reinforcing structure, not represented, for example a support extending

in the longitudinal direction of the spars 13, in particular a metal support, can be arranged in the hollow space 07, on which the chamber wall 13 is supported at least in part or at points.

Modified embodiments of those in Figs. 1 to 4 are represented in Figs. 6 to 9, in which the wall 13 with the micro-openings 12 takes the place of the support 08 and the layer 09, 09'.

In Fig. 6 the leg areas 03 have the micro-bores 12 in the chamber wall 13 facing the web 06, at least in their folding edge areas.

Fig. 7 shows the embodiment of the chamber wall 13 as a tube 13, which has a micro-perforation (micro-bores 12), at least in the area of the folding edges.

In Fig. 8 the embodiment of the hollow space 07 and the arrangement of micro-bores 10 as far as into the nose section 04 is represented corresponding to Fig. 3.

For the embodiment of the micro-openings 03 as openings of bores 12, an excess pressure in the chamber 04 of maximally 2 bar, in particular of 0.1 to 1 bar, is of advantage.

Corresponding to Fig. 5, Fig. 9 shows the embodiment of zones of different development of micro-perforations. Thus, for example, the diameter of the micro-bores 12' in the nose section 04 (for example 90 to 150 μm) can be larger than that in the leg area 03 (for example 60 to 110 μm), and/or the hole density in the nose section 04 (greater than 0.3 / mm^2) can be greater than the one in the leg area (for example greater than 0.2 / mm^2). Also, instead of or additionally to this it is possible to provide different hollow chambers 07,

07' for the nose and leg areas, wherein the hollow space 07' assigned to the nose section 04 is charged with a higher excess pressure (for example less than 3 bar, but greater than the excess pressure in the leg area 03) than the one in the leg area 03 (for example less than 2 bar, in particular less than 1 bar).

The bores 12 can be embodied cylindrical, funnel-shaped or in another special shape (for example in the form of a Laval nozzle).

The micro-perforation, i.e. producing the bores 12, preferably takes place by drilling by means of accelerated particles (for example a liquid, such as a water jet, ions or elementary particles), or by means of electromagnetic radiation of high energy density (for example light in the form of a laser beam). Producing by means of an electron beam is particularly advantageous.

The side of the wall 13 having the bores 12 and facing the web 06, for example a wall 13 made of special steel, in a preferred embodiment has a dirt- and/or ink-repelling finish. It has a non-represented coating - for example of nickel or advantageously chromium - which does not cover the openings 10 or bores 12, and which for example has been additionally treated - for example with micro-ribs or structured in a lotus flower-effect, or preferably polished to a high gloss).

In a variation, the wall 13 with the bores 12 is embodied as an insert or as several inserts in a support. The insert can be connected fixedly or exchangeably with the support. The latter is of advantage in respect to cleaning or an exchange of inserts with different micro-perforations for matching different inks, printing formats, etc.

Fig. 10 shows a basic sketch of a further embodiment of the former 01, wherein the leg areas 03 are constituted by the spars 08 and the nose section 04 by its own support 08' or support body 08' forming a hollow space 07'. In Fig. 10 the layer 09 is not represented in the leg and nose areas 03, 04. Since this embodiment form is to be applied in the same way to the exemplary embodiment with the micro-bores 12, the components were correspondingly doubly identified. The leg areas 03 then have the wall 13, and the nose section 04 the chamber wall 13'.

In a non-represented embodiment the upper element supporting the leg areas 03 can also be embodied as a double-walled hollow body which has the bores 15 and the layer 09, or the micro-bores 12 - in the leg area 03 and possibly also in the triangularly-shaped area lying inbetween -.

In a further development (Fig. 11), the traction roller pair 02 making the fold is not embodied as rotatable rollers, but as a folding device 02 with two oppositely located surfaces, which have micro-openings 10 on their sides facing the web 06 (or the strand). These surfaces with the micro-openings 10 can be arranged on a common support body 16 enclosing a common hollow chamber 07, on a common support body 16 enclosing two separate hollow spaces 07, or on two separate support bodies 16, each of which has a hollow space 07. In one of the two above mentioned embodiments, the micro-openings 10 are embodied as open pores in a porous material 09 or as openings of micro-pores 10 and can be charged from the hollow space 07 with compressed air. In one case a layer 09 together with bores 15 has been applied to the inside of the support body 07, in the other case this

side has micro-bores 12. The web 06 or the strand is passed between the surfaces facing each other and is provided with its linear or back fold. For this purpose the distance between the surfaces tapers for example in the direction of the running web 02.

The folding device 02 can be advantageously embodied in addition to one of the mentioned formers 01 having micro-openings 10, or independently of the embodiment of the former 01 in the described design.

List of Reference Symbols

01	Former
02	Traction roller pair, folding device
03	Leg area, web guide plate
04	Nose section, nose
05	-
06	Web, web of material, web of material to be imprinted, paper web
07	Inner chamber, hollow chamber, chamber, pressure chamber
08	Support, support material support body, tube, spar
09	Micro-porous material, sinter material, layer, micro-porous, coating
10	Opening, micro-opening
11	Cover, plate
12	Bore, micro-bore
13	Wall, chamber wall, tube, spar
14	Printing gap
15	Opening, passage, bore
16	Support body
07'	Hollow chamber
08'	Support, support body
09'	Micro-porous material
12'	Bore, micro-bore
13'	Chamber wall